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Shocks and Relationships

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No. 07/2009

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Ninghua Du¹ and Maroš Servátka²

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Abstract: In this paper we experimentally study effects of exogenous revenue shocks on long-term relationships between firms and workers. While we find that shocks have no significant effect on wages and a little effect on the duration of relationships, we observe their significant effect on effort levels: given the same wage, the workers exert lower effort in the condition with shocks than in the condition with no shocks. As a result, the presence of shocks in our experiment decreases market efficiency.

Keywords: Experiment, exogenous revenue shocks, gift exchange

JEL Classifications: C91, D82, J41

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Shocks and Relationships

1. Introduction

Brown *et al.* (2004) find that in stationary conditions of an experimental labor market with the possibility of repeated interactions between firms and workers long-term relationships emerge endogenously even without third party enforcement of the contracts. The majority of trades are initiated by firms making private offers to individual workers who in turn exert high levels of effort throughout all the periods. The competition resulting from excess labor supply seems to have little impact on wages which remain substantially higher than the market clearing level.

However, in practice many (if not all) firms operate in variable or uncertain market conditions. Firms' profitability can be affected by changes in demand for their products, technology they use, input costs or by changes in other variables; warranting an extension of existing experimental designs to include non-stationarity as a boundary condition. In this paper we study the effects of revenue fluctuations on long-term relationships between firms and workers.

But why would revenue shocks influence firm-worker interactions (other than through standard economic variables)? A wide body of psychology literature points out that external stimuli impinge on relationships (e.g., Cialdini (2007), Menon and Sheldon (2008)). We suspect that this could be the case with economic relationships as well especially in scenarios when fairness is a salient consideration (e.g., Güth *et al.* (1982), Kahneman *et al.* (1986)). The central premise of our paper is that the revenue shocks disrupt long-term relationships between two transacting parties despite the fact that staying in a relationship might dominate the outside option.

In a related study Fehr *et al.* (1996) provide experimental evidence that firms with better profit opportunities pay systematically higher wages and higher job rents.¹ This result points out a channel (i.e., wages and effort) through which the shocks could disrupt relationships. However, because there is no reputation building in Fehr *et al.* experiment, their design does not permit a conclusion as to whether fluctuations in firm's profitability affect long-term relationship between a firm and a worker.

¹ Fehr *et al.* vary the firms' revenue coefficients to make them more or less productive.

We explore this question in an experiment designed to give subjects an opportunity to form and sustain relationships in non-stationary conditions. While we find that revenue shocks had no significant effect on wages and little effect on relationships, we observe some impact of shocks on market efficiency: the workers exert lower effort and the realized potential surplus is lower when revenue shocks exist.

2. Experimental Design

We modify the experimental design of Brown *et al.* (2004) by introducing exogenous revenue shocks to a firm's payoff:

$$\pi_f = \begin{cases} A^*e - w & \text{if a contract is concluded} \\ 0 & \text{if no contract is concluded} \end{cases},$$

where A is the revenue coefficient, $w \in \{1, 2, \dots, 100\}$ is the wage paid to a worker, and $e \in \{1, 2, \dots, 10\}$ is the effort exerted by the contracted worker. Worker receives a payoff:

$$\pi_w = \begin{cases} w - c(e) & \text{if a contract is concluded} \\ 5 & \text{if no contract is concluded} \end{cases},$$

where $c(e)$ is the cost of exerting effort. The cost schedule is presented in table 1.

Total Effort	1	2	3	4	5	6	7	8	9	10
Total Cost	0	1	2	4	6	8	10	12	15	18
Marginal Cost	0	1	1	2	2	2	2	2	3	3

Table 1. Cost of effort schedule

Seven firms and ten workers participate in each experimental labor market. Each participant's role and ID are fixed throughout the experiment. There are 15 trading periods, each lasting 3 minutes. A firm can employ at most one worker and each worker can accept a maximum of one job offer per period.

A trading period has two stages. In the first stage, firms make contract offers to workers. A worker can either accept one of the offers or deny them, in which case he earns 5 experimental dollars. An offer includes a wage, a desired effort level, and the firm's ID. During the trading period a firm can make private offers that only reach a specified worker and public offers that reach all available workers. As soon as a worker accepts one of the firm's offers, all the firm's other standing offers

immediately disappear from the market. If a firm and a worker conclude a contract, they enter the second stage. In the second stage, the worker chooses an effort level after which the period payoffs are determined.

We implement two experimental conditions, *Shocks* and *No Shocks*, in an across-subjects design. In *Shocks* condition, A is either equal to 10 or 7, with a 50/50 probability. This information is common knowledge. Each firm observes its own coefficient A but not coefficients of other firms. The firm's coefficient A is revealed to the worker who had a contract with the firm after the worker had submitted the effort level. Otherwise a worker does not observe any firm's coefficient A . In *No Shocks* condition, the coefficient A is always fixed at 7 for all firms.

Under the rationality and selfishness assumptions, workers will choose the minimum effort, $e = 1$, regardless of the wage offered. The prevailing wage in the market is close to the workers' reservation wage and such outcome is obviously not efficient. According to the cost schedule $c(e)$ in table 1, the marginal cost of effort is at most 3. Because A is either equal to 10 or 7, the efficient level of effort is $e = 10$.

In Brown *et al.* (2004) both wages and effort levels are above the market clearing level and are even higher if the interaction is repeated, providing evidence that relationships can be an important economic variable. Within this framework we compare *Shocks* condition and *No Shocks* condition in three dimensions: the stability of relationships as measured by their duration, the wages offered by firms, and the effort provided by workers.

3. Procedures and Analysis

The experiment was programmed and conducted with the software z-Tree (Fischbacher (2007)). We ran four *Shocks* sessions and three *No Shocks* sessions in the Economic Science Laboratory, University of Arizona and three *Shocks* and three *No Shocks* sessions at SHUFE Economics Lab in Shanghai in spring semester 2006.² The recruited subjects were undergraduate students from the respective universities.³ The average payoff in the sessions conducted was 25 USD in Arizona and 30 Yuan in

² The primary reason for running the experiment at two different locations was exceeding the dissertation budget at the University of Arizona. We found no significant difference in behavior between Arizona and Shanghai students.

³ There were 2 sessions in Arizona where less than 17 subjects showed up and several graduate students from Economics, Finance, and Accounting were asked to serve as subjects to fill in the empty spots.

Shanghai.⁴ The average on-campus wage of a University of Arizona student was around 7 USD per hour and in Shanghai around 12 Yuan per hour at the time of the experiment.

The Length of Relationships

In No Shocks we observed 622 transactions in 6 sessions with a total of 306 relationships. In Shocks we observed 713 transactions in 7 sessions with a total of 399 relationships. The average relationship length in No Shocks was 2.03 periods while in Shocks it was 1.77 periods. We cannot reject the hypothesis that the length of relationships in Shocks is the same as in No Shocks at the 5% significance level (Means test $p = 0.081$ and Mann-Whitney test $p = 0.346$). This finding is supported by another observation that the relationships do not break up significantly more often following a wage decrease in Shocks than in No Shocks (2-sided Fisher exact test $p = 0.464$).

Wages

Figure 1 shows that in Shocks the average wage given the high revenue ($A=10$) is higher for most periods than the average wage given the low revenue ($A=7$). We apply the Mann-Whitney test to session averages as individual observations to test the hypothesis that the firms in high revenue periods offer wages at the same level as the firms in low revenue periods. The null is rejected at the 1% significance level ($p = 0.003$). In line with Fehr *et al.* (1996), this result indicates that firms offer higher wages in periods with high revenues.

The firms in Shocks have on average higher marginal revenue than in No Shocks. Based on the previous result, the firms in Shocks should on average offer higher wages than in No Shocks. The question is whether firms offer higher wages also in the low revenue periods in Shocks than in No Shocks. If the wages in Shocks do not fluctuate and are above the wage level in No Shocks, then the data would provide support for wage rigidity as observed by Brown *et al.* (2004). If such wage rigidity exists, it is caused by the employer's concern for long-term relationship.

The average wage across all periods in No Shocks (26.94) is almost the same as the average wage in low revenue periods in Shocks (26.37). The Mann-Whitney test with session averages as individual observations supports this observation and does

⁴ The exchange rate at the time of the experiment was 1 USD = 8 Yuan.

not reject the hypothesis that the wages in the two samples are equal ($p = 0.350$). Our data thus provide evidence that Brown *et al.* (2004) wage rigidity result is robust to the boundary conditions with exogenous revenue shocks.

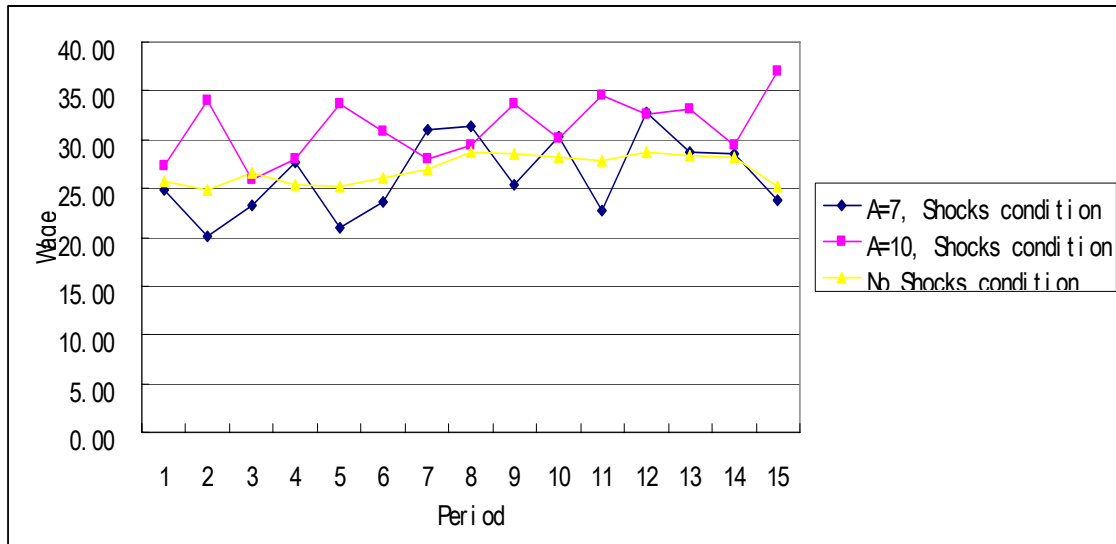


Figure 1. Average wage

Effort

The average effort level for a given period in No Shocks is significantly higher than in Shocks (Means $p = 0.000$ and Mann-Whitney $p = 0.000$).⁵ In figure 2 we also observe a last-period effect as the average effort level in period 15 is much lower than in all previous periods. Because the effort level is an indicator of market efficiency (i.e., the total surplus) in our setting, the market outcome in No Shocks is also more efficient than in Shocks despite its lower average revenue coefficient.

⁵ However, the Mann-Whitney test with session averages as individual observations is not significant ($p = 0.361$).

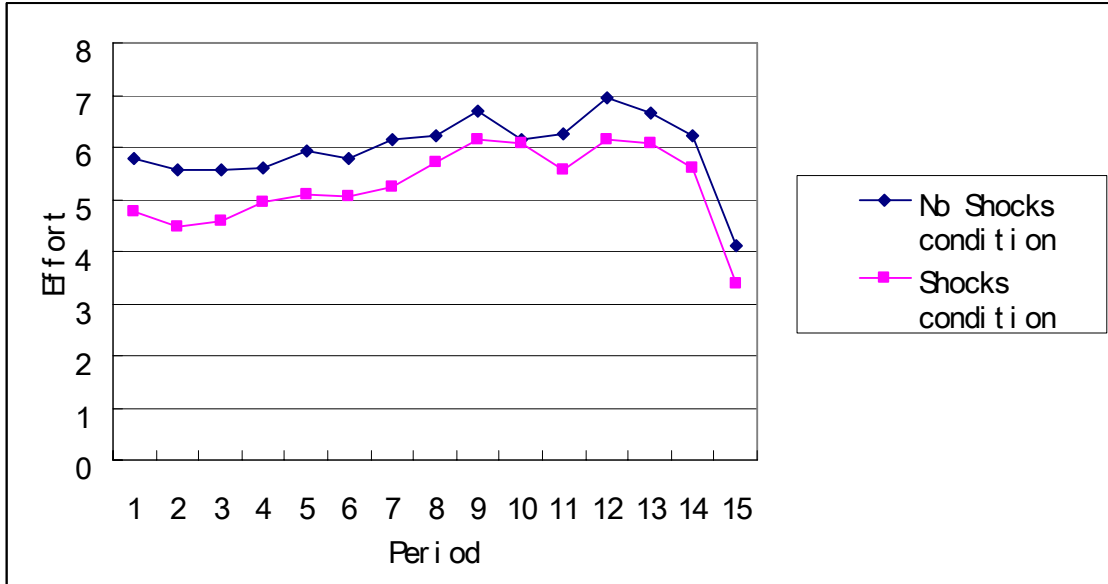


Figure 2. Average effort

In order to better assess the difference in effort levels between No Shocks and Shocks conditions Table 2 reports their comparison given the control for received wages.⁶ The regression results show that given the same wage, the effort level in Shocks is on average lower by 1.02 than in No Shocks.

<i>Effort</i>	<i>Coefficient</i>	<i>St. Error</i>	<i>t</i>	<i>P> t </i>
<i>Constant</i>	1.46	0.128	11.40	.000
<i>Shock</i>	-1.02	0.113	-8.97	.000
<i>Wage</i>	0.16	0.003	45.93	.000

Table 2. A comparison of effort levels between Shocks and No Shocks ($n = 1335$)

4. Discussion

We report results of a laboratory experiment studying the impact of exogenous shocks to firms' revenues on long-term relationship between firms and workers as well as the corresponding market performance. While we find that shocks had no significant effect on wages and little effect on relationships, we observe clear evidence in effort levels: given the same wage, the workers exert significantly lower effort in Shocks comparing to No Shocks. Hence, the presence of shocks in our experiment decreases market efficiency.

⁶ In the regression, Shock is a dummy variable (1 for Shocks and 0 for No Shocks).

The current experiment does not permit a conclusion as to what were the reasons for the workers to exert lower levels of efforts when uncertain market conditions were present nor whether this problem would be alleviated if the realization of coefficient A was known to both the firm and the worker. Gächter and Riedl (2005) study suggests that the entitlement effect could have been responsible for the observed behavior. However, a different design, specifically aimed to address this issue is needed.

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Appendix Instructions (Shocks)

Buyer #.....

Instructions for Buyers

You are now taking part in an economic experiment. Please read the following instructions carefully. Everything that you need to know in order to participate in this experiment is explained below. Should you have any difficulties in understanding these instructions please notify us. We will answer your questions at your cubicle.

At the beginning of the experiment you will receive an initial endowment of **5 US Dollars**. During the course of the experiment you can earn a further amount of money by gaining **points**. The amount of points that you gain during the experiment depends on your decisions and the decisions of other participants.

All points that you gain during the course of the experiment will be exchanged into US Dollars at the end of the experiment. The exchange rate will be:

1 point = 0.1 US Dollars

At the end of the experiment you will receive the money that you earned during the experiment in addition to your endowment of 5 US Dollars.

The experiment is divided into periods. In each period you have to make decisions, which you will enter on a computer screen. There are 15 periods in all.

Please note that communication between participants is strictly prohibited during the experiment. In addition we would like to point out that you may only use the computer functions which are required for the experiment. Communication between participants and unnecessary interference with computers will lead to the exclusion from the experiment. In case you have any questions don't hesitate to ask us.

Prior to the experiment the 17 participants were divided into 2 groups: buyers and sellers. In this experiment there are 10 sellers and 7 buyers.

You are a buyer throughout the whole experiment. All participants have received an identification number which they will keep for the entire experiment. Your identification number is stated on the documentation sheet in front of you.

An Overview of the Experimental Procedures

In each period of the experiment every buyer can buy a product from a seller. The seller earns a profit by trading if he sells the product at a price, which exceeds his production costs. The buyer earns a profit by trading if the price he pays for the product is less than what the product is worth to him. The production costs and the product's value for the buyer depend on the quality of the product.

The experiment lasts for 15 periods. In each period the procedures are as follows:

1. Each period starts with a **trading phase** which lasts for 3 minutes. During this phase buyers can submit offers, which can be accepted by sellers. When submitting an offer a buyer has to specify **three things**:
 - which price he offers to pay,
 - which product quality he desires,
 - and finally, which seller he wants to submit the offer to. Buyers can submit two types of offers; private offers and public offers. **Private offers are submitted to one seller only** and can only be accepted by that seller. **Public offers are submitted to all sellers** and can be accepted by any seller.

As a buyer you can - in each period - submit as many offers as you like. Submitted offers can be accepted at any time during the trading phase. **Each buyer and each seller can at most conclude one trade in each period.** As there are 10 sellers and 7 buyers, several sellers will not trade in each period.

2. Following the trading phase each seller who has concluded a trade determines which product quality he will supply. **The seller is not obliged to supply the product quality desired by his buyer.** Once every seller has chosen a product quality each participant's earnings in the current period are determined. After this the next period starts.

The points gained from all 15 periods will be summed up at the end of the experiment, exchanged into US Dollars and paid together with your endowment in cash.

The Experimental Procedures in Detail

There are 7 buyers and 10 sellers in the experiment. You are a buyer throughout the whole experiment. During the experiment you will enter your decisions on a computer screen. In the following we describe in detail how you can make your decisions in each period.

1. The Trading Phase

Each period starts with a trading phase. During the trading phase each buyer can conclude a trade with a seller. In order to do so **each buyer can submit as many offers as he wishes.** In each trading phase you will see the following screen:

Period 1 out of 1			Remaining time [sec]:		
Public Offers			Your Private Offers		
Buyer	Price	Des. Q.	Price	Des. Q.	To Seller
<div style="display: flex; justify-content: space-between;"> <div> <p>Your ID Number</p> <p>Here you make your offers</p> <p>Your Coefficient A</p> <p><input type="radio"/> Public</p> <p><input type="radio"/> Private</p> <p>If private, to which seller? <input style="width: 50px;" type="text"/></p> <p>Your Price <input style="width: 50px;" type="text"/></p> <p>Desired Quality <input style="width: 50px;" type="text"/></p> <p style="text-align: right; color: red; font-weight: bold;">OK</p> </div> <div> <p><input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5</p> <p><input type="checkbox"/> 6 <input type="checkbox"/> 7 <input type="checkbox"/> 8 <input type="checkbox"/> 9 <input type="checkbox"/> 10</p> </div> </div>					
Your Seller		Your Price	Your Des. Q.		

- In the top left corner of the screen you see in which period of the experiment you are. In the top right corner of the screen you will see the time remaining in this trading phase, displayed in seconds. **The trading phase in each period lasts 3 minutes** (=180 seconds). When this time is up the trading phase is over. Hereafter, no further offers can be submitted or accepted in this period.
- On the right hand side of the screen you can see your ID number and your “coefficient A.” The detailed description of the coefficient A and how A is related to your income will be discussed in the section “how are the incomes calculated.”
- Once the above screen is displayed the trading phase starts. As a buyer you now have the opportunity to submit offers to the sellers. In order to do so you have to enter three things on the right hand side of the screen:

a) First you have to specify whether you want to submit a public or a private offer:

- **Public trade offers**

Public offers will be communicated to all participants in the market. All sellers see all public offers on their screens. A public offer can therefore be accepted by **any seller**. As a buyer you will also see all public offers submitted by all buyers.

If you want to submit a public offer, click on the field "public", using the mouse.

- **Private trade offers**

A private offer is submitted to **one seller only**. Only this seller is informed about the offer and only this seller can accept the offer. No other seller or buyer will be informed about that offer.

If you want to submit a private offer, click on the field "private" using the mouse. After that you specify **which seller** you want to submit the offer to in the field below. Each of the 10 sellers has an identification number (seller 1, seller 2,, seller 10). Each seller keeps his identification number throughout the whole experiment. To submit an offer to a specific seller you enter the number of that seller (e.g., "4" for seller 4).

b) Once you have specified to whom you want to submit an offer, you must determine **which price you offer**. You enter this in the field "Your price". The price you offer is a number between 0 and 100:

$$0 \leq \text{price offered} \leq 100$$

c) Finally you have to specify which product quality you desire. You enter this in the field "Desired quality". Your **desired quality** is a number between 1 and 10:

$$1 \leq \text{desired quality} \leq 10$$

After you have completely specified your offer, you must click on the "OK" button to submit it. As long as you have not clicked "OK" you can change your offer. After you click "OK" the offer will be displayed to all sellers you have submitted it to.

- On the left side of your screen you see the header "public offers". All public offers in the current trading phase are displayed here. Your public offers as well as those of all other buyers will be displayed. You can see which buyer submitted the offer, which price he offered and which quality he desired. All buyers also have an identification number, which they keep throughout the whole experiment.
- In the middle of your screen under the header "Your private offers". You see all private offers, which you have submitted in the current trading phase. You see which price you offered, which quality you desired and which seller you submitted an offer to.
- **Each buyer can submit as many private and public offers as he wishes in each period.** Each offer that you submit can be accepted at any time during the trading phase.
- **In any given period each buyer can conclude at most one trade.** Once one of your offers has been accepted you will be notified which seller accepted which of your offers. In the bottom right corner of your screen the identification number of the seller will be displayed as well as your offered price and your desired quality. As you can conclude only one trade in each period all your other offers will be automatically cancelled. Also, you will not be able to submit any further offers.

- **In any given period each seller can conclude at most one trade.** You will be continuously informed which sellers have not yet accepted an offer. On the right bottom of the screen you see 10 fields, each field for one of the ten sellers. Once a seller has accepted an offer a “x” will appear in the field next to the seller’s identification number. You cannot submit private offers to a seller who has already concluded a trade.
- Once all 7 buyers have concluded a trade or after 3 minutes have elapsed, the trading phase is over.
- No buyer is obliged to submit offers, and no seller is obliged to accept an offer.

2. Determination of the Product Quality

- Following the trading phase, all sellers who have concluded a trade determine which product quality they supply to their respective buyers. **The product quality, which you desired in your offer, is not binding for your seller.** Your seller can choose the exact quality you desired, but he can also choose a higher or a lower product quality. The product quality which your seller chooses has to be between 1 and 10:

$$1 \leq \text{product quality} \leq 10$$

- While your seller determines the actual product quality, we ask you to specify which quality you expect him to supply on a separate screen. In addition we ask you to state how sure you are about this expectation.

How are the Incomes Calculated?

Your income:

- If you do not conclude a trade during a trading phase you receive an income of 0 points in that period.
- If one of your offers is accepted, your income depends on the price you offered and on the product quality. Your income is determined as follows:

$$\text{Your income} = A * \text{product quality} - \text{price}$$

In each period, with probability of 0.5 your coefficient A in the above equation is equal to 10, and A is equal to 7 with the same probability. The coefficient A is independent of the periods and A is also independent of the buyers. Your coefficient A is shown to you in the “**trading phase screen**” at the beginning of the period.

- As you can see from the above formula your income is higher, the higher the product quality actually supplied by your seller. At the same time your income is higher, the lower the price you paid for the product.

Income of your seller:

- If a seller has not concluded a trade during a trading phase he gains an income of 5 points in that period.
- If a seller has accepted an offer his income equals the price he receives minus the production costs he incurs. The income of the seller is determined as follows:

$$\text{Income of your seller} = \text{Price} - \text{production costs}$$

- The production costs of a seller are higher, the higher the quality he chooses. The production costs for each product quality are displayed in the table below:

Product quality	1	2	3	4	5	6	7	8	9	10
Production costs	0	1	2	4	6	8	10	12	15	18

- The income of your seller is higher, the higher the price. Further, his income is higher, the lower the product quality he supplies.

The income of all buyers and sellers are determined in the way as described above. **Each buyer can therefore calculate the income of his seller and each seller can calculate the income of his buyer.** Further, each buyer and seller is informed about the identification number of his trading partner in each period.

Please note that buyers and sellers can incur losses in each period. These losses have to be paid from your initial endowment or from earnings made in other periods.

You will be informed about your income and the income of your seller on an "**income screen**". On the screen (see below) the following will be displayed:

- which seller you traded with
- which price you offered
- your desired quality
- the product quality actually chosen by your seller
- the income of your seller in this period
- your income in this period.

Period	1 out of 1	Remaining time [sec]:
--------	------------	-----------------------

Your ID Number

Your Coefficient A

The following offer has been accepted

ID number of your seller

Price

Desired Quality

Actually chosen quality

Income of your seller

Your Income =

Continue

Please enter all the information in the documentation sheet supplied to you. After the income screen has been displayed, the period is over. Thereafter the trading phase of the following period starts. Once you have finished studying the income screen please click on the "continue" button.

The sellers also see an income screen, which displays the above information. They see the ID of their trading partner, the price, desired and actually supplied product quality as well as both incomes.

The experiment will not start until all participants are completely familiar with all procedures. In order to secure that this is the case we kindly ask you to solve the exercises below.

In addition we will conduct **2 trials of the trading phase**, so that you can get accustomed to the computer. During the trial phases no money can be earned. After the trial phases we will begin the experiment, which will last for 15 periods.

Control Questionnaire

Please solve the following exercises completely. If you have questions ask the experimenter.

Exercise 1

You did not make an offer during a trading phase. What is your income in this period?

Your income =

Exercise 2

Your coefficient A is equal to 10. You offered a price of 30 and indicated a desired quality of 9. A seller accepts your offer and actually chooses a quality of 8.

Your income =

Income of your seller =

Exercise 3

Your coefficient A is equal to 7. You offered a price of 60 and indicated a desired quality of 9. A seller accepts your offer and actually chooses a quality of 6.

Your income =

Income of your seller =

Exercise 4

Your coefficient A is equal to 7. You offered a price of 10 and indicated a desired quality of 2. A seller accepts your offer and actually chooses a quality of 5.

Your income =

Income of your seller =

Exercise 5

Your coefficient A is equal to 10. You offered a price of 10 and indicated a desired quality of 6. A seller accepts your offer and actually chooses a quality of 2.

Your income =

Income of your seller =

Exercise 6

A seller did not accept an offer during a trading phase. What is the income of this seller in this period?

Income of your seller =

Exercise 7

You made several offers during a trading phase. None of your offers has been accepted by a seller. What is your income in this period?

Your income =

If you have finished the exercises we recommend looking again at the exercises and the solutions provided. After this, please think about the decisions you want to make during the experiment.

Documentation sheet: Buyer

This documentation sheet is meant for your orientation. Please complete the respective row in each period.

Period	ID of Your Seller	Price	Desired Quality	Actual Quality	Income of Your Seller	Your Income
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Instructions for Sellers

You are now taking part in an economic experiment. Please read the following instructions carefully. Everything that you need to know in order to participate in this experiment is explained below. Should you have any difficulties in understanding these instructions please notify us. We will answer your questions at your cubicle.

At the beginning of the experiment you will receive an initial endowment of **5 US Dollars**. During the course of the experiment you can earn a further amount of money by gaining **points**. The amount of points that you gain during the experiment depends on your decisions and the decisions of other participants.

All points that you gain during the course of the experiment will be exchanged into US Dollars at the end of the experiment. The exchange rate will be:

1 point = 0.1 US Dollars

At the end of the experiment you will receive the money that you earned during the experiment in addition to your endowment of 5 US Dollars.

The experiment is divided into periods. In each period you have to make decisions which you will enter in a computer. In total there are 15 periods.

Please note that communication between participants is strictly prohibited during the experiment. In addition we would like to point out that you may only use the computer functions which are required for the experiment. Communication between participants and unnecessary interference with computers will lead to the exclusion from the experiment. In case you have any questions don't hesitate to ask us.

Prior to the experiment the 17 participants were divided into 2 groups: buyers and sellers. In this experiment there are 10 sellers and 7 buyers.

You are a seller throughout the whole experiment. All participants have received an identification number which they will keep for the entire experiment. Your identification number is stated on the documentation sheet in front of you.

An Overview of the Experimental Procedures

In each period of the experiment every buyer can buy a product from a seller. The seller earns a profit by trading if he sells the product at a price which exceeds his production costs. The buyer earns a profit by trading if the price he pays for the product is less than what the product is worth to him. The production costs and the product's value for the buyer depend on the quality of the product.

The experiment lasts 15 for periods. In each period the procedures are as follows:

1. Each period starts with a **trading phase**, which lasts for 3 minutes. During this phase buyers can submit trade offers which can be accepted by sellers. When submitting an offer a buyer has to specify **three things**:

- which price he offers to pay,
- which product quality he desires,
- and finally, which seller he wants to submit the offer to. Buyers can submit two types of offers; private offers and public offers. **Private offers are submitted to one seller only** and can only be accepted by that seller. **Public offers are submitted to all sellers** and can be accepted by any seller.

Buyers can - in each period - submit as many offers as they like. Submitted offers can be accepted at any time during the trading phase. **Each buyer and each seller can only conclude one trade in each period.** As there are 10 sellers and 7 buyers, several sellers will not trade in each period.

2. Following the trading phase each seller who has concluded a trade determines which product quality he will supply. **The seller is not obliged to supply the product quality desired by his buyer.** Once every seller has chosen a product quality each participant's earnings in the current period are determined. After this the next period starts.

The points gained from all 15 periods will be summed up at the end of the experiment, exchanged into US Dollars and paid together with your endowment in cash.

The Experimental Procedures in Detail

There are 7 buyers and 10 sellers in the experiment. You are a seller throughout the whole experiment. During the experiment you will enter your decisions on a computer screen. In the following we describe in detail how you can make your decisions in each period.

1. The Trading Phase

Each period starts with a trading phase. During the trading phase each buyer can conclude a trade with a seller. In order to do this the buyers can submit offers to the sellers. As a seller you can - in each period - accept one of the offers. During the trading phase you will see the following screen:

Period 1 out of 1	Remaining time(sec):
Your ID-number	

Private offers to you			Public offers		
from Buyer	Price	des. Q.	from Buyer	Price	des. Q.
<input type="button" value="accept"/>			<input type="button" value="accept"/>		

Your Buyer	Your Price	des. Q.

- In the top left corner of the screen you see in which period of the experiment you are. In the top right corner of the screen you see the remaining time in the current trading phase, displayed in seconds. **The trading phase in each period lasts 3 minutes** (=180 seconds). When this time is up the trading phase is over. Hereafter, no further offers can be submitted or accepted for this period.
- Once the above screen is displayed the trading phase starts. As a seller you can now accept offers submitted by the buyers. There are two types of offers which you can accept:
 - **Private offers to you**
Each buyer has the opportunity to submit private offers to you. **You alone will be informed about these offers and you alone can accept them.** No other seller or buyer is informed about these offers. If you receive private offers, they will appear on the left side of your screen, below the header "Private offers to you". The offer of a buyer contains the following information: the identification number of the buyer who submitted the offer, the price which he offers for the product and which product quality he desires. If you want to accept a private offer, you click first on the respective row in which the offer is displayed. When you do this, the offer will be highlighted. If you are sure you want to accept the offer you then click on the button "accept" which you find at the bottom of the screen. As long as you do not click "accept" you can alter your choice.

- **Public offers**

Each buyer also has the possibility to submit public offers. All sellers are informed about these offers and **any seller can accept them**. If a buyer submits a public offer it appears on the right side of your screen, below the header "Public offers". The offer of a buyer again contains the identification number of the buyer who submitted the offer, the price which he offers for the product and which product quality he desires. This information is also displayed to all other sellers and all buyers. If you want to accept a public offer you follow the same procedures as with private offers. You click first on the respective row in which the offer is displayed. When you are sure that you want to accept the offer you click on the button "accept" which you find at the bottom right corner of the screen. As long as you do not click "accept" you can alter your choice.

- As soon as you have pressed the “accept” button you will see which offer you have accepted in the bottom row of your screen.
- **Each seller can conclude at most one trade in each period.** Once you have accepted one offer you cannot accept any further offers.

All buyers have to observe the following rules when submitting trade offers:

- The price offered by the buyer must be between 0 and 100:

$$0 \leq \text{price} \leq 100$$

- The **desired quality** of the buyer must be between 1 and 10:

$$1 \leq \text{desired quality} \leq 10$$

- **Each buyer can - in each period - submit as many private and public offers as he wishes.** Each offer submitted by a buyer can be accepted at any time during the trading phase.
- **Each buyer can conclude at most one trade in each period.** Once an offer of a buyer has been accepted he will be informed about which seller accepted the offer. As each buyer can conclude only one trade in each period all other offers of the buyer will automatically be cancelled. Also, he cannot submit any further offers.
- Once all 7 buyers have concluded a trade or after 3 minutes have elapsed, the trading phase is over.
- No buyer is obliged to submit offers, and no seller is obliged to accept an offer.

2. Determination of the Actual Product Quality

- Following the trading phase, all sellers who have concluded a trade determine which product quality they supply to their buyers. **The product quality desired by your buyer is not binding for you as a seller.** You can exactly choose the

quality desired by your buyer, but also a higher or lower product quality. If you have concluded a trade during a trading phase, the following screen will appear. Here, you have to enter the product quality:

Period 1 out of 1

You accepted the following offer

From buyer

Price

Desired quality

Choose the actual quality

OK

In order to choose the actual product quality, you enter the value for the quality in the field "Choose the actual quality" and press the "OK" button to confirm your choice. As long as you have not pressed "OK" you can alter your choice.

- The product quality you choose must be an integer between 1 and 10:

$$1 \leq \text{product quality} \leq 10$$

How are the Incomes calculated?

Your income:

- If you have **not concluded a trade** during a trading phase you receive an income of **5 points** in that period.
- If you have accepted an offer your income depends on the price you accepted and the product quality you choose to deliver. Your income is calculated as follows:

$$\text{Your income} = \text{Price} - \text{production costs}$$

- Your production costs are higher, the higher the quality of the product you chose to deliver. The production costs for each product quality are displayed in the table below:

Product quality	1	2	3	4	5	6	7	8	9	10
Production costs	0	1	2	4	6	8	10	12	15	18

- Your income is therefore higher, the lower the product quality. Further, your income is higher, the higher the price.

The income of your buyer:

- If a buyer does not conclude a trade during a trading phase he receives an income of 0 points in that period.
- If one of his offers is accepted, his income depends on the price he offered and the product quality. The income of your buyer will be determined as follows:

$$\text{Income of your buyer} = A * \text{product quality} - \text{price}$$

In each period, with probability of 0.5 your buyer's coefficient A in the above equation is equal to 10, and A is equal to 7 with the same probability. Your buyer's coefficient A is independent of the periods and A is also independent of the other buyers. Your buyer's coefficient A is shown to you in the "**income screen**" at the end of the period.

- As you can see from the above formula the income of your buyer is higher, the higher the product quality actually supplied by you. At the same time his income is higher, the lower the price he paid for the product.

The income of all buyers and sellers are determined in the way as described above. **Each buyer can therefore calculate the income of his seller and each seller can calculate the income of his buyer.** Further, each buyer and each seller is informed about the identification number of his trading partner in each period.

Please note that buyers and sellers can incur losses in each period. These losses have to be paid from the initial endowment or from earnings made in other periods.

You will be informed about your income and the income of your buyer on an "**income screen**". On the screen (see below) the following will be displayed:

- Which buyer you traded with
- Your buyer's coefficient A
- Which price he offered
- The desired quality of your buyer
- The product quality actually chosen by you
- The income of your buyer in this period
- Your income in this period.

Period	Remaining time [sec]:
1 out of 1	

Your ID Number

You accepted the following offer

ID number of your buyer

Your buyer's coefficient A

Price

Desired Quality

Actually chosen quality

Income of your buyer

Your Income =

Continue

Please enter all the information in the documentation sheet supplied to you. After the income screen has been displayed, the period is over. Thereafter the trading phase of the following period starts. Once you have finished studying the income screen please click on the "continue" button.

The buyers also see an income screen, which displays the above information. They see the ID of their trading partner, the price, the desired and the supplied product quality as well as both incomes.

The experiment will not start until all participants are completely familiar with all procedures. In order to secure that this is the case we kindly ask you to solve the exercises below.

In addition we will conduct **2 trials of the trading phase**, so that you can get accustomed to the computer. During the trial phases no money can be earned. After the trial phases we will begin the experiment, which will last for 15 periods.

Control Questionnaire

Please solve the following exercises completely. If you have questions ask the experimenter.

Exercise 1

You did not accept an offer during a trading phase. What is your income in this period?

Your income =

Exercise 2

You accepted an offer with a price of 30 and a desired quality of 9. You supplied an actual quality of 8.

Your income =

Income of your buyer =

Exercise 3

You accepted an offer with a price of 60 and a desired quality of 9. You supplied an actual quality of 4.

Your income =

Income of your buyer =

Exercise 4

You accepted an offer with a price of 40 and a desired quality of 2. You supplied an actual quality of 5.

Your income =

Income of your buyer =

Exercise 5

You accepted an offer with a price of 30 and a desired quality of 6. You supplied an actual quality of 6.

Your income =

Income of your buyer =

Exercise 6

A buyer has made several offers during a trading phase. None of these offers has been accepted by a seller. What is the income of the buyer in this period?

Income of buyer =

If you have finished the exercises we recommend looking again at the exercises and the solutions provided. After this, please think about the decisions you want to make during the experiment.

Documentation sheet: Seller

This documentation sheet is meant for your orientation. Please complete the respective row in each period.

Period	ID of Your Buyer	Price	Desired Quality	Actual Quality	Income of Your Buyer	Your Income
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						